

Translation

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY  
(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference <b>543-60.762PCT/AP/zi</b>	<b>FOR FURTHER ACTION</b>		See Form PCT/IPEA/416
International application No. <b>PCT/EP2004/004841</b>	International filing date (day/month/year) <b>06.05.2004</b>	Priority date (day/month/year) <b>07.05.2003</b>	
International Patent Classification (IPC) or national classification and IPC			
<p>Applicant <b>PERKINELMER OPTOELECTRONICS GMBH &amp; CO. KG</b></p>			

<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of <u>7</u> sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> (<i>sent to the applicant and to the International Bureau</i>) a total of <u>4</u> sheets, as follows:</p> <p><input checked="" type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p>b. <input type="checkbox"/> (<i>sent to the International Bureau only</i>) a total of (indicate type and number of electronic carrier(s)) _____, containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p> <p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the report</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input type="checkbox"/> Box No. VIII Certain observations on the international application</p>
--

Date of submission of the demand	Date of completion of this report
Name and mailing address of the IPEA/EP	Authorized officer
Facsimile No.	Telephone No.

## INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/EP2004/004841

## Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

This report is based on translations from the original language into the following language \_\_\_\_\_ which is the language of a translation furnished for the purposes of:

international search (Rule 12.3 and 23.1(b))  
 publication of the international application (Rule 12.4)  
 international preliminary examination (Rule 55.2 and/or 55.3)

2. With regard to the **elements** of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):

the international application as originally filed/furnished  
 the description:  
 pages 1-24 as originally filed/furnished  
 pages\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_  
 pages\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_

the claims:  
 nos. \_\_\_\_\_ as originally filed/furnished  
 nos.\* 1-15 as amended (together with any statement) under Article 19  
 nos.\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_  
 nos.\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_

the drawings:  
 sheets 1-8 as originally filed/furnished  
 sheets\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_  
 sheets\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_

a sequence listing and/or any related table(s) – see Supplemental Box Relating to Sequence Listing.

3.  The amendments have resulted in the cancellation of:

the description, pages \_\_\_\_\_  
 the claims, nos. \_\_\_\_\_  
 the drawings, sheets/figs \_\_\_\_\_  
 the sequence listing (*specify*): \_\_\_\_\_  
 any table(s) related to sequence listing (*specify*): \_\_\_\_\_

4.  This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

the description, pages \_\_\_\_\_  
 the claims, nos. \_\_\_\_\_  
 the drawings, sheets/figs \_\_\_\_\_  
 the sequence listing (*specify*): \_\_\_\_\_  
 any table(s) related to sequence listing (*specify*): \_\_\_\_\_

\* If item 4 applies, some or all of those sheets may be marked "superseded."

## INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.  
PCT/EP2004/004841

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

## 1. Statement

Novelty (N)	Claims	1-15	YES
	Claims		NO
Inventive step (IS)	Claims		YES
	Claims	1-15	NO
Industrial applicability (IA)	Claims	1-15	YES
	Claims		NO

## 2. Citations and explanations (Rule 70.7)

Reference is made to the following documents:

D1: EP-A-0 599 364 (MATSUSHITA ELECTRIC WORKS LTD),  
1 June 1994 (1994-06-01)

D2: DE 101 44 343 A (PERKINELMER OPTOELECTRONICS GM),  
27 March 2003 (2003-03-27)

1. The application fails to meet the requirements of PCT Article 33(1) because the subject matter of independent claim 1 does not involve an inventive step (PCT Article 33(3)).

Document D1 discloses the following (see figures 57 to 59, and column 15, lines 45 to 47 in the description; the references in parentheses are to D1):

A radiation sensor ("infrared detector 14")  
with  

- a substrate ("substrate 12"),
- a cavity ("cavity") formed in one surface of the substrate, which may be a depression or a through-hole,
- a sensor element ("infrared detector 14")

## INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/EP2004/004841

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

over the cavity, preferably on a membrane spanning the cavity ("thermally infrared absorbing film 13"), and

- electrical contacts for the sensor element (see elements 16Qa and 16Qb in figure 59),

characterised in that

- the cavity in the surface of the substrate has a fully or partially rounded contour (see figure 59).

The subject matter of claim 1 differs from the known radiation sensor in that at least a portion of the lateral wall of the cavity is perpendicular to the surface of the substrate, and in that the cavity is created by dry etching.

The problem addressed by the present invention can thus be seen as that of designing a radiation sensor that makes better use of the space (see the discussion about wasted space on page 4 of the description).

The solution proposed in claim 1 of the application cannot be considered inventive (PCT Article 33(3)) for the following reasons:

Document D2 states (see paragraph 5) that particularly small radiation sensors can be produced by ion etching. This is because of the vertical lateral walls that can be obtained using such a process (see column 2, lines 1

## INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/EP2004/004841

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

and 2). Hence the solution to the technical problem of interest is known in its entirety from D2.

2. The application fails to meet the requirements of PCT Article 33(1) because the subject matter of independent claim 15 does not involve an inventive step (PCT Article 33(3)).

Document D1, which is considered to be the prior art closest to the subject matter of claim 15, discloses the following (see the description, column 10, line 1 to column 11, line 37; the references in parentheses are to D1):

Process for producing a radiation sensor, comprising the following steps:

- producing a flat wafer ("silicon substrate"),
- applying an etching stop layer ("silicon oxide film") to a first surface of the wafer, followed by a mechanically stable membrane ("nitride film"),
- applying an etching mask to a second surface of the wafer (there is no mention of an etching mask in the description, but those skilled in the art know that such masks are used in the process in question (KOH etching)), the etching mask having one or more openings with an at least partially rounded contour (this variant is shown in figure 59 and described at column 15, lines 45 to 47), and
- etching cavities in the wafer, starting from the

## INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.  
PCT/EP2004/004841Box No. V **Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

second surface and proceeding towards the etching stop layer ("the cavity 11G is formed in the substrate 12G on the side opposite to that having the infrared detector 14G, by means of the anisotropic etching carried out with potassium hydroxide").

The subject matter of claim 15 differs from the known process for producing a radiation sensor in that a dry etching process is used.

The problem addressed by the present invention can thus be seen as that of designing a radiation sensor that makes better use of the space (see the discussion about wasted space on page 4 of the description).

The solution proposed in claim 15 of the application cannot be considered inventive (PCT Article 33(3)) for the following reasons:

Document D2 states (see paragraph 5) that particularly small radiation sensors can be produced by ion etching. This is because of the vertical lateral walls that can be obtained using such a process (see column 2, lines 1 and 2). Hence the solution to the technical problem of interest is known in its entirety from D2.

3. Dependent claims 2 to 14 do not contain any features that meet the PCT requirements in respect of novelty or inventive step when combined with the features of any of the back-referenced claims. The reasons for this are as follows:

**INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY**

International application No.  
PCT/EP2004/004841

**Box No. V** **Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

Claims 2-4, 6-8, 10-13: Additional features disclosed in D1 (see figures 52 to 54, 59, 61 and 63; column 10, line 1 to column 11, line 37, and column 15, lines 45 to 47) (PCT Article 33(2)).

Claim 5: Additional features known from a comparable radiation sensor (see D2, paragraph 42) (PCT Article 33(3)).

Claim 9: The figures seem to be within the normal range for micromechanical radiation detectors. The proportions specified for the cavity diameter follow directly from the round shape of the cavity and the square contour, both of which are known from D1 (PCT Article 33(3)).

Claim 14: The effect of imaging elements such as mirrors and lenses are generally known in the art in the context of optical radiation detectors (PCT Article 33(3)).

## CLAIMS

1. Radiation sensor (10) comprising  
a support (1),  
a cavity (2) which may be a recess or a through hole formed in  
one surface of the support (1),  
a sensor element (4, 4a, 4b) formed above the cavity (2), pref-  
erably on a membrane (3) covering the cavity (2), and  
electric terminals (5, 5a, 5b) for the sensor element (4, 4a, 4b),  
characterised in that  
the cavity (2) in the surface of the support (1) has an entirely  
or partially rounded contour (2a),  
the side wall of the cavity (2) extends at least partially perpen-  
dicularly to the support surface, and  
the cavity (2) has been formed through dry etching.
2. Radiation sensor (10) according to claim 1, characterised in that  
the support (1) has a rectangular and particularly a square con-  
tour (1a).
3. Radiation sensor (10) according to claim 1 or 2, characterised in  
that the cavity (2) has an oval or round contour (2a).
4. Radiation sensor (10) according to claims 2 and 3, characterised  
in that one or more electric terminals (5, 5a, 5b) are provided in  
a corner section (6, 6a – 6d) of the sensor (10).

5. Radiation sensor (10) according to one or more of the preceding claims, characterised in that the sensor element (4, 4a, 4b) is a thermopile.
6. Radiation sensor according to one or more of the preceding claims, characterised in that a plurality of sensor elements are formed above one cavity.
7. Radiation sensor according to one or more of the preceding claims, characterised in that the cavity (2) in the surface of the support (1) has a contour defined not only by straight lines.
8. Radiation sensor (10) according to one or more of the preceding claims, characterised by one or more of the following features:
  - the membrane material comprises a dielectric, particularly silicon oxide and/or silicon nitride,
  - under the membrane an etching stop layer containing an oxide, particularly silicon oxide, is provided,
  - the support material contains silicon and/or GaAs and/or a semiconductor material.
9. Radiation sensor (10) according to one or more of the preceding claims, characterised by one or more of the following dimensions:
  - support height H: more than 50  $\mu\text{m}$ , preferably more than 200  $\mu\text{m}$ , less than 1,500  $\mu\text{m}$ , preferably less than 600  $\mu\text{m}$ ,
  - support edge length L: less than 2 mm, preferably less than 1.5 mm,

- cavity diameter D: more than 55 %, preferably more than 65 % and/or less than 90 %, preferably less than 80 % of the support edge length L,
- membrane thickness D: less than 3  $\mu\text{m}$ , preferably more than 0.1  $\mu\text{m}$ .

10. Wafer (30) comprising a plurality of blanks for radiation sensors (10) according to one or more of the preceding claims formed on it, characterised in that the blanks are arranged on the wafer (30) in a rectangular, rhombic, triangular or hexagonal pattern (31, 32).

11. Sensor array (40) comprising a plurality of radiation sensors (10) according to one or more of claims 1 to 9.

12. Sensor array (40) according to claim 11, characterised in that a plurality of radiation sensors (10) are arranged in two or more rows (41) and in two or more columns (42).

11. Sensor module (50) comprising

- a radiation sensor (10) according to one or more of claims 1 to 9 or a sensor array (20) according to claim 11 or 12,
- a housing (51) in which the radiation sensor (10) or the sensor array (20) is accommodated,
- an optical window (52) in the housing (51), and
- electric terminals (53) protruding from the housing (51), said electric terminals (53) being connected to the terminals (5, 5a, 5b).

14. Sensor module (50) according to claim 13, characterised by an optical projection element, particularly a lens (52) or a mirror.
15. Method for manufacturing a radiation sensor (10), comprising the steps:
  - production of a plane wafer,
  - application of an etching stop layer on a first surface of the wafer and formation of a mechanically stable membrane on top of it,
  - application of an etching mask having one or more openings of at least partially rounded contour on a second surface of the wafer, and
  - dry etching of cavities of the wafer from the second surface in the direction towards the etching stop layer such that the side wall of the cavity (2) extends at least partially perpendicularly to the first surface of the wafer.